

Effect of a Cross Wind on Rifled Projectiles.

By A. MALLOCK, F.R.S.

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The effect of wind on rifled projectiles is important for practical reasons, especially in the case of small arms, but the object of the present note is not so much to determine the actual effect of wind as to show that accurate experiments on the subject would afford valuable information concerning the flight of projectiles in still air.

It is easily shown that if the air resistance acts always in the direction of the resultant of the velocities of the wind and the projectile, the angle made by the resultant velocity with the line of aim remains constant throughout the range and is independent of the law connecting velocity and retardation.*

In order, however, that the resistance may act in the direction of the resultant velocity, the projectile must be symmetrical about that direction. This, in the case of any form except a sphere, means that the principal axis of the projectile must take the direction of the resultant velocity.

If this is assumed and we take v_0 as the initial velocity of the shot, w as the velocity of the wind (w/v_0 being small) and ξ and η as the co-ordinates of the shot parallel and perpendicular respectively to the line of aim, ξ being measured from a moving origin at $v_0 t$; we have at the time t

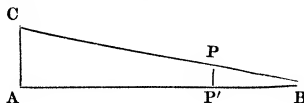
$$v = v_0 - \dot{\xi}, \quad R = v_0 t - \xi, \quad \text{and} \quad \eta = \xi w / v_0;$$

hence
$$\eta = \frac{w}{v_0} (v_0 t - R) \quad \text{or} \quad w \left(t - \frac{R}{v_0} \right). \quad (1)$$

This result was first given by Captain Younghusband, R.N., and would be correct if the axis of the projectile set itself in the direction of the resultant velocity from the very beginning.

At first, however, the axis makes an angle w/v_0 with the velocity resultant, and the resistance has therefore a horizontal component at right angles to

* Let AB be the initial velocity and direction of the shot. AC the velocity and direction of the wind. The resultant velocity of the shot through the air is CB. Let



CP be the velocity after the air resistance has given the shot a negative velocity BP in the direction BC. The components of the resultant velocity parallel and perpendicular to AB are $AB - PB$ and $AC - PP'$, and their ratio AC/AB as before.

that resultant, for the same reason that a small angle between the axis of the projectile and the tangent to the trajectory produces an upward force on the former.

The difference between the two cases lies in the fact that whereas the angle between the axis and the tangent (and therefore also the upward force) must remain finite throughout the range, the horizontal lateral force diminishes indefinitely with the time and, for the greater part of a long range, the direction of the axis of the projectile and the velocity resultant may be taken as identical. The reason for this is, of course, the constancy of the direction of the velocity resultant.

The question then as to how far (1) may be looked on as giving a true value for the effect of the wind turns on the rate at which the projectile can set its axis in the direction of the velocity resultant.

The couple required to turn the axis of a rifled projectile at a given angular velocity can readily be determined in terms of its mass, form, and spin, but what the angle between the axis of the projectile and the direction of its motion must be in order that the air may cause this couple to act, is not known, and cannot at present be calculated.

It is shown, however, in a former paper,* that to produce a given angular velocity of the axis of a projectile the couple must vary as the fourth power of the linear dimension.

For a given inclination of the axis to the direction of motion the couple applied by action of the air will vary as the cube of the linear dimension; thus the angular velocity of the axis will be inversely as the linear dimension; or in other words the time for a given angle will be as the linear dimensions.

For a given inclination the lateral force will be as the square of the linear dimension and the distance to which the lateral force will carry the projectile while turning through the angle w/v_0 will be proportional to the linear dimension.

Thus, instead of the expression in (1) we should write

$$\eta = AL + w(t - R/v_0), \quad (2)$$

where L denotes the linear dimension, and A some constant depending on the form, weight, and initial velocity of the projectile.

If careful experiments were made on wind deflection, the velocity of the wind being recorded at several positions along the range at the instant that each shot was fired,† the value of A might be determined, and therefrom the

* "The Behaviour of Rifled Projectiles in Air," 'Roy. Soc. Proc.,' vol. 79, p. 547.

† I cannot find that any experiments of the kind have been made up to the present.

angle which the axis of a projectile fired in still air makes with the tangent to the trajectory.

Attempts have been made to measure this angle photographically, but hitherto without success, and the method here indicated, though indirect, would, I think, be more likely to attain the desired result.

On the Decay of the Radium Emanation when dissolved in Water.

By RICHARD B. MOORE, B.Sc.

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The results obtained by Ramsay and Cameron* on dissolving radium emanation in water and in copper sulphate solution have made it advisable to investigate the behaviour of the emanation, when dissolved in such solvents, from a radio-active standpoint. There are two possible explanations for the results obtained by these authors:—

(1) The one advanced by them to the effect that the α -particle is not identical with the helium atom, but that the “degradation” of the large molecule of the emanation is effected by bombardment with α -particles, the products of the degradation varying according to whether, on the one hand, the emanation is alone or mixed with other gases, or, on the other, whether it is dissolved in water or copper sulphate solution.

(2) The α -particle is a helium atom under ordinary conditions, but when the emanation is dissolved in water or copper sulphate solution an α -particle of greater mass is split off from the emanation atom.

If the latter explanation be correct the disintegration products of the emanation when it is dissolved in water or copper sulphate solution ought to be different from those obtained from the emanation when alone or mixed with air. An investigation of these disintegration products should throw light on the subject.

The present note deals with the rate of decay of the radium emanation when dissolved in water. The emanation accumulated by 110 milligrammes of radium bromide in two days, with the accompanying oxygen and hydrogen, was collected in a gas burette over mercury. After exploding, a small amount of water was run into the burette, and the solution of the emanation

* ‘Chem. Soc. Trans.’ vol. 91, p. 1593, 1907.